1. Name of Experiment/Project/Collaboration: Daya Bay Reactor Neutrino Experiment
2. Physics Goals
   a. Primary: precise determination of neutrino mixing angle θ_{13} and effective mass-splitting Δm^2_{ee}
   b. Secondary: precise measurement of absolute flux and energy spectrum of reactor antineutrinos, search for sterile neutrinos, observation of supernova neutrinos and new neutrino interactions
3. Location of the experiment/project: Daya Bay Nuclear Power Facility, Shenzhen, China
4. Neutrino source: electron antineutrinos from nuclear reactors
5. Primary detector technology: liquid scintillator and photomultiplier tubes (PMTs)
6. Short description of the detector

   There are eight antineutrino detectors (ADs) located in two near and one far underground halls. Each AD consists of three nested cylindrical vessels. The inner two are acrylic, 3 m tall by 3 m in diameter and 4 m tall by 4 m in diameter. The outer one is a 5 m tall and 5 m in diameter stainless steel tank. The inner vessel is filled with 20 t of 0.1% gadolinium-loaded liquid scintillator, which is surrounded by 21 t of unloaded liquid scintillator. Between the stainless steel and the 4-m acrylic vessels is 37 t of mineral oil. There are 192 PMTs mounted on the inner surface of the cylinder. The ADs are shielded by at least 2 m of ultra-pure water in pools which are instrumented as two optically decoupled water Cherenkov detectors for tagging cosmic-ray muons. The top of each pool is covered by a layer of resistive-plate chambers.
7. List key publications and/or archive entries describing the project/experiment.

   (1) F.P. An et al., Nucl. Instrum. Meth. A**685** (2012) 78.
   (2) F.P. An et al., Phys. Rev. Lett. **108** (2012) 171803.
   (3) F.P. An et al., Chin. Phys. C**37** (2013) 011001.
   (4) F.P. An et al., Phys. Rev. Lett. **112** (2014) 061801.
   (5) F.P. An et al., Phys. Rev. D**90** (2014) 071101(R).
   (6) F.P. An et al.,Phys. Rev. Lett. **113** (2014) 141802.
8. Collaboration
   a. Institution list:

   (1) Brookhaven National Laboratory, *Upton, NY, USA*
   (2) Beijing Normal University, *Beijing, China*
   (3) China Guangdong Nuclear Power Group, *Shenzhen,* Guangdong, *China*
   (4) Charles University, *Prague, Czech*
   (5) China Institute of Atomic Energy, *Beijing, China*
   (6) Catholic University of Chile, *Santiago, Chile*
   (7) Chinese University of Hong Kong, *Hong Kong, China*
   (8) Dongguan University of Technology, *Dongguan,* Guangdong*, China*
   (9) Joint Institute for Nuclear Research, *Dubna, Russia*
   (10) East China University of Science and Technology, *Shanghai, China*
   (11) University of Hong Kong, *, Hong Kong, China*
   (12) Institute of High Energy Physics, *Beijng, China*
   (13) Illinois Institute of Technology, *Chicago, IL, USA*
   (14) Iowa State University, *Ames, IA, USA*

(15) Lawrence Berkeley National Laboratory, *Berkeley, USA*
(16) Nankai University, *Tianjin, China*
(17) North China Electric Power University, *Beijing, China*
(18) National Chiao-Tung University, *Hsinchu, Taiwan, China*
(19) Nanjing University, *Nanjing, China*
(20) National Taiwan University, *Taipei, Taiwan, China*
(21) College of Electronic Science and Engineering, *Changsha, Hunan, China*
(22) National United University, *Miao-Li, Taiwan, China*
(23) Princeton University, *Princeton, NJ, USA*
(24) Rensselaer Polytechnic Institute, *Troy, NY, USA*
(25) Shandong University, *Jinan, Shandong, China*
(26) Siena College, *Loudenville, NY, USA*
(27) Shanghai Jiao Tong University, *Shanghai, China*
(28) Shenzhen University, *Shenzhen,* Guangdong*, China*
(29) Temple University, *Philadelphia, PA, USA*
(30) Tsinghua University, *Beijing, China*
(31) University of Cincinnati, *Cincinnati, USA*
(32) University of California at Berkeley, *Berkeley, CA, USA*
(33) University of Houston, *Houston, TX, USA*
(34) University of Illinois at Urbana-Champaign, *Urbana, IL, USA*
(35) University of Science and Technology of China, *Hefei, China*
(36) Virginia Polytechnic Institute and State University, Blacksburg, *VA, USA*
(37) University of Wisconsin, *Madison, WI, USA*
(38) College of William and Mary, *Williamsburg, VA, USA*
(39) Xi'an Jiaotong University, *Xi'an, China*
(40) Yale University*, New Haven, CT, USA*
(41) Sun Yat-Sen (Zhongshan) University, *Guangzhou,* Guangdong*, China*

b. Number of present collaborators: 253
c. Number of collaborators needed: 253

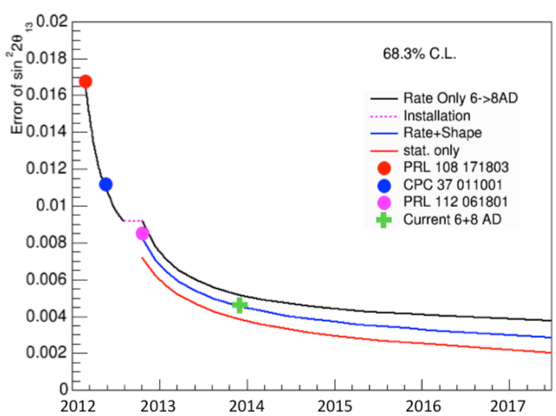
9. R&D
   a. List the topics that will be investigated and that have been completed:
      i. synthesis of linear alkyl benzene-based gadolinium-doped liquid scintillator with excellent optical properties and long-term stability.
      ii. light, thin, flexible magnetic shield for photomultiplier tubes.
      iii. Design and fabrication of scintillator compatible, thin-walled nested acrylic vessels
   b. Which of these are crucial to the experiment:
      i. the 0.1% gadolinium-loaded liquid scintillator provides an effective means to capture the neutrons produced in the inverse beta-decay reaction of the reactor antineutrinos, giving rise to an 8-MeV delayed signal which is significantly more energetic than those from radioactive contaminants. In addition, the relatively short capture time reduces the amount of accidental coincidence. Both features greatly reduce background.

ii. The magnetic shield significantly reduces the effect of the earth's magnetic field and leads to more uniform energy resolution throughout the fiducial volume. This is important for precision measurement.
iii. The acrylic vessel assembly contains the liquid scintillator and is used for the antineutrino detection inside the detector

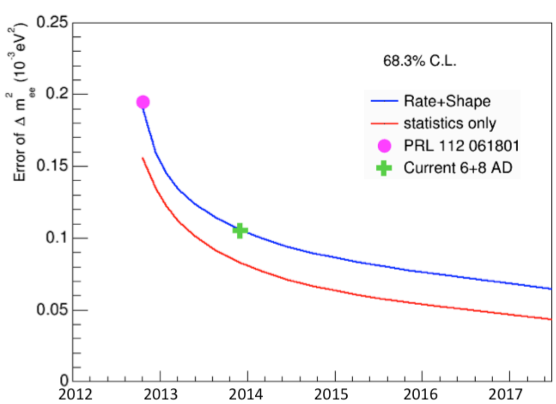
c. Time line: complete.
d. Benefit to future projects:
    i. established a recipe for synthesizing metal-loaded liquid scintillators with excellent optical properties and long-term stability. Linear alkyl benzene has a high flash point, is non-toxic, biodegradable, and is relatively cheap.
    ii. Identified FINEMET as an excellent thin foil for shielding magnetic fields. It is cheaper than mu-metal and is easier to work with.
    iii. US knowledge in design and fabrication of acrylic containment vessels for liquid scintillator is used in future experiments (e.g LZ neutron shield)

10. Primary physics goal expected results/sensitivity:
    a. For exclusion limit (such as sterile neutrino search), show 3-sigma and 5-sigma limits: NA
    b. For discovery potential (such as the Mass Hierarchy), show 3-sigma and 5-sigma: NA
    c. For sensitivity plots, show 3-sigma and 5-sigma sensitivities:

Precision of $\sin^2 2\theta_{13}$ as a function of time



Precision of Δm^2_{ee} as a function of run time



By 2017, the precision of $\sin^2 2\theta_{13}$ and Δm^2_{ee} will be ~0.003 and ~7 x 10^{-5} eV^2 respectively – the most precise in the world for the foreseeable future. The improved precision on $\sin^2 2\theta_{13}$ will improve the precision on measurements of the CP violating phase δ by future long baseline experiments.

d. List the sources of systematic uncertainties included in the above, their magnitudes and the basis for these estimates.

	efficiency	correlated	uncorrelated
target protons		0.47%	0.03%
flasher cut	99.98%	0.01%	0.01%
delayed energy cut	90.9%	0.6%	0.12%
prompt energy cut	99.88%	0.10%	0.01%
multiplicity cut		0.02%	<0.01%
capture time cut	98.6%	0.12%	0.01%
Gd capture fraction	83.8%	0.8%	<0.1%
spill-in	105.0%	1.5%	0.02%
livetime	100.0%	0.002%	<0.01%
combined	78.8%	1.9%	0.2%

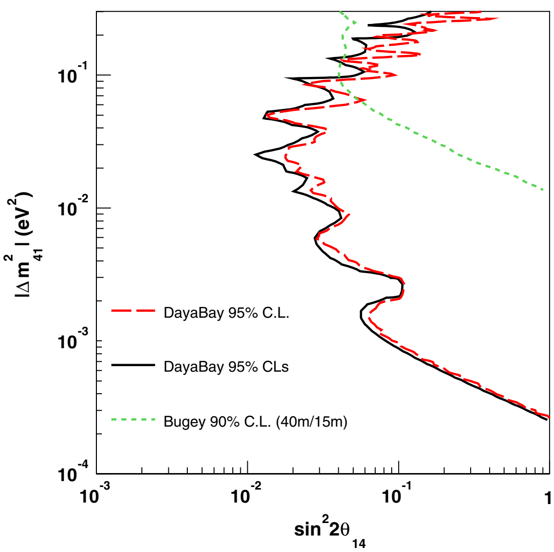
From Publication (3).

The uncertainties are determined using measurements and/or simulation.

e. List other experiments that have similar physics goals: Double Chooz, RENO, T2K, NOvA

f. Synergies with other experiments: Double Chooz, RENO, T2K, NOvA, JUNO, LBNE

11. Secondary Physics Goal
    a. Expected results/sensitivity
        i. Search for a light sterile neutrino



From Publication (6)

The expected sensitivity in searching for a light sterile neutrino by 2017 will be improved by a factor of 4.

        ii. Measurement of the absolute flux and energy spectrum of reactor antineutrinos: precision on the flux will be 1-2%, and a few percent for the spectrum.

    b. List other experiments that have similar physics goals: Double Chooz, RENO

12. Experimental requirements
    a. Provide requirements (neutrino source, intensity, running time, location, space,…) for each physics goal
        i. Source: nuclear reactors
        ii. rate: 3.6×10^{21} antineutrinos/s
        iii. running time: 6 years
        iv. location: Daya Bay Nuclear Power Station, Shenzhen, China
        v. overburden: ~100 m for the near halls, and 330 m for the far hall
        vi. baseline: 360 m and 500 m for the near halls, ~1700 m for the far hall.

13. Expected Experiment/Project time line
    a. Design and development: 2005-2008
    b. Construction and Installation: 2007-2011
    c. First data: 2011
    d. End of data taking: 2017
    e. Final results: 2020
14. Estimated cost range
    a. US contribution to the experiment/project: 35 million US dollars
    b. International contribution to the experiment/project: 50 million US dollars
    c. Operations cost: US$5 million/year (total) that includes $1.5M/year from the U.S..
15. The Future
    a. Possible detector upgrades and their motivation: Various options for upgrades of Daya Bay are under consideration, including modifications for high resolution measurement of reactor antineutrino spectrum, measurement of $\sin^2 2\theta_W$, continued running for $\sin^2 2\theta_{13}$ and supernova bursts,…
    b. Potential avenues this project could open up: The measurement of $\sin^2 2\theta_{13}$ has been critically important for the entire field of neutrino physics, enabling resolution of mass hierarchy and searches for CP violation. Improved precision by Daya Bay is critically important for improved precision in these determinations and for tests of the 3-ν model.